DECLARATION

I, Yutaka Horii, c/o Fukami Patent Office, Nakanoshima Central Tower, 22nd Floor, 2-7, Nakanoshima 2-chome, Kita-ku, Osaka-shi, Osaka, Japan, declare:

that I know well both the Japanese and English languages;

that to the best of my knowledge and belief the English translation attached hereto is a true and correct translation of Japanese Patent Application No. 2000-076125, filed on March 17, 2000;

that all statements made of my own knowledge are true;

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[Title of the Invention] CATV Tuner

[Scope of Claims for Patent]

[Claim 1] A CATV tuner, comprising: an upstream circuit for transmitting a data signal to a CATV (cable television) station; a high pass filter for introducing a multiwave down signal from said CATV station while removing said data signal; and a receiving unit receiving the down signal introduced by said high pass filter, wherein

said upstream circuit includes

a variable gain amplifying circuit amplifying the data signal to said CATV station with a prescribed gain, and

a coupling circuit coupling an output of said amplifying circuit to an input of said high pass filter; and

said receiving unit includes

a tuner portion taking out and amplifying a signal corresponding to a reception channel from said down signal and converting it to an intermediate frequency signal of a first frequency band, and

a down converter portion receiving the intermediate frequency signal of said first frequency band, and selectively outputting an intermediate frequency signal of said first frequency band or a second frequency band lower than said first frequency band.

[Claim 2] The CATV tuner according to claim 1, wherein

said down converter portion includes

a local oscillation circuit generating an oscillation signal corresponding to said second frequency band in a first mode in which the intermediate frequency signal of said second frequency band is output, and stopping generation of said oscillation signal in a second mode in which the intermediate frequency signal of said first frequency band is output,

a mixer circuit for mixing the intermediate frequency signals of said first frequency band input to said down converter portion with an output of said local

oscillation circuit, and

a filter circuit receiving an output signal from said mixer circuit and passing a signal of a frequency corresponding to a set cut off frequency.

[Claim3] The CATV tuner according to claim 1, wherein

said tuner portion includes a first AGC portion for adjusting amplitude of a signal corresponding to said reception channel to a prescribed level,

said tuner further comprising

a second AGC portion provided between said tuner portion and said down converter portion, for adjusting amplitude of the intermediate frequency signal of said first frequency band to a prescribed level.

[Claim 4] The CATV tuner according to claim 1, wherein

said tuner portion and said down converter portion output signals of non-parallel type; said tuner further comprising

a signal converting circuit receiving an output of said down converter portion and converting to a parallel type signal.

[Claim 5] The CATV tuner according to claim 1, wherein

said mixer circuit amplifies the intermediate frequency signal of said first frequency band in said second mode.

[Claim 6] The CATV tuner according to claim 5, wherein

said local oscillation circuit includes

an oscillation element oscillating at said second frequency band,

a first bipolar transistor receiving at an input electrode an output of said oscillation element,

a first bias resistance coupled between the input electrode of said first transistor and a first voltage node, and

a second bias resistance coupled between one of output electrodes of said first bipolar transistor and a first voltage node; and

said mixer circuit includes

a second bipolar transistor receiving at an input electrode an output of said oscillation element and the intermediate frequency signal of said first frequency band,

a third bias resistance coupled between input electrodes of said first and second bipolar transistors, and

a fourth bias resistance coupled between the input electrode of said second bipolar transistor and a second voltage node supplying a voltage higher than said first voltage node.

[Claim 7] The CATV tuner according to claim 6, wherein

said local oscillation circuit includes a switch element of which on/off is instructed externally, connected parallel to said oscillation element,

said switch element turning on/off in said first and second modes, respectively.

[Claim 8] The CATV tuner according to claim 1, wherein

a down data signal of a band different from said multiwave down signal is input from said CATV station to said receiving unit through a cable, and

said receiving unit includes a branching circuit branching and outputting said down data signal.

[Claim 9] The CATV tuner according to claim 1, wherein

said upstream circuit, said tuner, said high pass filter and said down converter are contained in a shield case partitioned individually.

[Detailed Description of the Invention]

[0001]

[Technical Field to Which the Invention Belongs]

The present invention relates to a CATV tuner. More specifically, the present invention relates to a CATV tuner suitable for outputting an intermediate frequency signal to a QAM demodulating circuit.

[0002]

[Prior Art]

In a cable television system (hereinafter referred to as CATV), introduction of

HFC (Hybrid Fiber/Coax) has been in progress, in which a coaxial cable is kept as a subscriber's drop wire and the main network is implemented by optical fibers. This system attempts to provide broadband data communication service of several Mbits/sec at home. Utilizing this system, it is possible to realize high-speed data line having the transmission rate of 30 Mbits/sec with the bandwidth of 6MHz using 64 QAM (Quadrature Amplitude Modulation), which may not be called the state of the art any more. The cable modem is used in this system, and realizes high-speed data communication of 4 Mbits/sec to 27 Mbits/sec, utilizing an unused channel of CATV. The cable modem tuner is used for a cable modem in such a cable television system, and after the received CATV signal is subjected to frequency conversion, it serves to take out the signal as an intermediate frequency signal.

[0003]

Fig. 8 is a block diagram representing a configuration of a conventional cable modem tuner 1.

As for the CATV signals, an up signal transmitted to a station has the frequency of 5MHz to 42MHz, and a down signal transmitted from the station to the cable modem tuner has the frequency of 54MHz to 860MHz, and transmitted to a cable network through an input terminal 2 of the tuner. The up signal transmitted from the cable modem is received by a data receiver of the CATV station (system operator), and enters a computer of a center.

[0004]

Referring to Fig. 8, the cable modem tuner 1 includes a cable television signal input terminal 2 receiving the cable television signal as an input, a data terminal 3 receiving a data signal from a QPSK transmitter as an input, and an upstream circuit 4 provided between data terminal 3 and cable television signal input terminal 2.

[0005]

In the cable modem, a data signal subjected to quadrature phase shift keying (QPSK) from a QPSK transmitter, for example, is input to data terminal 3 as the up

signal. The data signal is transmitted through upstream circuit 4 to the CATV station.

[0006]

The down signal input through input terminal 2 is divided into a UHF band (hereinafter also referred to as a B3 band) receiving the frequency of 470 to 860MHz, a VHF-High band (hereinafter also referred to as B2 band) receiving the frequency of 170 to 470MHz and a VHF-Low band (hereinafter also referred to as B1 band) receiving the frequency of 54 to 170MHz, and processed by receiving circuits provided for respective bands. Band ranges are not limited to those specified above.

[0007]

The cable modem tuner 1 further includes a high pass filter 5 having an attenuation range of 5 to 46MHz and a pass band of not lower than 54MHz, and input switching circuits 6 and 7 for allocating the signals passed through the high pass filter 5 to circuits corresponding to respective bands.

[0008]

The down signal is passed through high pass filter 5, the band is switched by the input switching circuits 6 and 7, and supplied to the circuitry corresponding to any of the aforementioned bands B1 to B3.

[0009]

Cable modem tuner 1 further includes high frequency amplification input tuning circuits 8, 9 and 10 provided corresponding to respective bands B1 to B3; high frequency amplification circuits 11 and 12 provided corresponding to the UHF band and VHF band, respectively; high frequency amplification output tuning circuits 15, 16 and 17 provided corresponding to respective bands B1 to B3; a mixer circuit 18 and a local oscillation circuit 19 provided corresponding to the UHF band; a mixer circuit 20 and a local oscillation circuit 21 provided corresponding to the VHF band; and an intermediate frequency amplifying circuit 22 for amplifying, in the intermediate frequency band, outputs from mixer circuits 18 and 20.

[0010]

The high frequency amplification input tuning circuits, the high frequency AGC circuits, the high frequency amplification output tuning circuits, the mixer circuits and the local oscillation circuits provided corresponding to respective bands are adapted such that dependent on the received channel, circuits corresponding to the received band are made operative, while the circuits corresponding to other bands are made inoperative. For example, when a UHF channel is received, the high frequency amplification input tuning circuit 8, the high frequency amplification circuit 11, high frequency amplification output tuning circuit 15, mixer circuit 18 and local oscillation circuit 19 for the UHF band are set to the operative state, while high frequency amplification input tuning circuits 9 and 10, high frequency amplification circuit 12, high frequency amplification output tuning circuits 16 and 17, mixer circuit 20 and local oscillation circuit 21 for the VHF-High and VHF-Low bands are set to inoperative state, and stop their operation.

[0011]

The CATV signal input to the input terminal 2 is passed through high pass filter 5 as described above, and enters input switching circuits 6 and 7, where band switching takes place. The output therefrom is fed to high frequency amplification input tuning circuit 8, 9 or 10, where channel selection takes place. After channel selection, the signal is input to AGC terminal 24, amplified to a prescribed level by high frequency amplification circuit 11 or 12 based on the AGC voltage applied through resistance 13 or 14, supplied to high frequency output tuning circuit 15, 16 or 17, where the received signal is extracted.

[0012]

Thereafter, the selected received signal is subjected to frequency conversion by mixer circuit 18, 20 and local oscillation circuit 19, 21 to an intermediate frequency (hereinafter also referred to as IF), and amplified by intermediate frequency amplification circuit 22.

[0013]

The intermediate frequency signal (hereinafter referred to as an IF signal) amplified by intermediate frequency amplifying circuit 22 is output from output terminal 23.

[0014]

In this manner, in the conventional cable modem tuner 1, a received CATV signal is selected in accordance with the reception channel, and the signal after channel selection is subjected to frequency conversion and output as an IF signal from output terminal 23.

[0015]

[Problems to be Solved by the Invention]

Handling of a QAM signal, which is a digital signal, and transmitting the IF signal output from output terminal 23 to a QAM demodulating circuit for QAM demodulation by using such a cable modem tuner 1 has the following various problems.

[0016]

(1) First, dependent on the type of QAM demodulating IC used as the QAM demodulating circuit, IF signal of a different frequency band becomes necessary. In the following description, of the IF signals, those output from the conventional cable modem tuner are described as having the frequency band of High-IF, and the frequency range generally not higher than 10MHz and lower than the High-IF will be referred to as Low-IF. At present, QAM demodulating ICs include ICs for receiving Low-IF QAM signals and ICs for receiving High-IF QAM signals. These result from the limitation imposed by the performance of analog/digital converter used in the QAM demodulating ICs. Accordingly, in order to attain a frequency range that can be received by the QAM demodulating IC connected in the succeeding stage, two different types of cable modem tuners have been necessary, or a frequency converting circuit positioned between the cable modem tuner and the QAM demodulating IC has been necessary.

[0017]

(2) It is specified in DOCSIS (cable modem specification in North America)

that the maximum output level of the transmitted upstream signal must be constant and + 58dBmV, and a signal level satisfying this specification is necessary at the input end of the tuner. The input level of the conventional cable modem tuner has been not up to this level.

[0018]

(3) According to DOCSIS, it is required that the upstream transmission signal can be variably controlled 1dB by 1dB, from +58 to +6dBV. Conventionally, such a function was not required.

[0019]

(4) According to DOCSIS specification, the high frequency level of the transmission signal must be at least – 50dBmV, and in the example shown in Fig. 8, it is necessary to improve significantly from the conventional level.

[0020]

(5) A further problem is that measures against digital noise are necessary. As the QAM demodulating IC requires high input signal level, an amplifier having a high gain is necessary. Therefore, when the overall system is configured, the clock noise and the bus noise of a CPU (Central Processing Unit) also come to have high levels. As it is a common practice to mount the QAM demodulating IC, the CPU and the cable modem tuner on one board, influence of such noises would be significant.

[0021]

Though a cable modem tuner is shown in Fig. 8 described above, a CATV tuner referred to as a digital set top box (hereinafter referred to as STB) has come to be used. In the cable modem, the down data signal transmitted from the CATV station is displayed on a television monitor, while in the STB, a QPSK modulated down data signal transmitted from the CATV station is branched from the tuner portion, and processed by CPU to be output to a personal computer.

[0022]

Accordingly, in the cable modem, an unused channel of the CATV in 54MHz to

860MHz band is used for transmitting the down data signal as described above, whereas in the STB, the frequency band of 70MHz to 130MHz is used.

[0023]

In the STB, there is a branching circuit provided for branching the down data signal on the output side of the HPF shown in Fig. 8, and the branched down data signal is output to an OOB (Out Of Band) terminal. The OOB terminal provides the branched data to CPU.

[0024]

In the STB also, as for the CATV signals, the up signal has the frequency of 5MHz to 42MHz and the down signal has the frequency of 54MHz to 860MHz, and connected to the cable network through input terminal 2. The up signal transmitted from the STB is received by the data receiver at the CATV station, and input to a computer of the center.

[0025]

In the STB, the data signal subjected to QPSK from QPSK transmitter (not shown) is introduced to the data terminal as the up signal. The data signal is fed to the STB by the computer at the center through the CATV circuit, processed by the CPU (not shown) in the STB, and applied to the QPSK modulator. Except for these points, the operation is similar to that in the cable modem tuner shown in Fig. 8, and hence, the STB also has the same problems as the cable modem tuner described above.

[0026]

The present invention was made to solve the above-described problems and its object is to provide a CATV tuner capable of outputting a signal suitable for QAM demodulation.

[0027]

[Means for Solving the Problems]

The present invention provides a CATV tuner, including: an upstream circuit for transmitting a data signal to a CATV (cable television) station; a high pass filter for

introducing a multiwave down signal from the CATV station while removing the data signal; and a receiving unit receiving the down signal introduced by the high pass filter, wherein the upstream circuit includes a variable gain amplifying circuit amplifying the data signal to the CATV station with a prescribed gain, and a coupling circuit coupling an output of the amplifying circuit to an input of the high pass filter; and the receiving unit includes a tuner portion taking out and amplifying a signal corresponding to a reception channel from the down signal and converting it to an intermediate frequency signal of a first frequency band, and a down converter portion receiving the intermediate frequency signal of the first frequency band, and selectively outputting an intermediate frequency signal of the first frequency band or a second frequency band lower than the first frequency band.

[0028]

Preferably, the down converter portion includes a local oscillation circuit generating an oscillation signal corresponding to the second frequency band in a first mode in which the intermediate frequency signal of the second frequency band is output, and stopping generation of the oscillation signal in a second mode in which the intermediate frequency signal of the first frequency band is output, a mixer circuit for mixing the intermediate frequency signals of the first frequency band input to the down converter portion with an output of the local oscillation circuit, and a filter circuit receiving an output signal from the mixer circuit and passing a signal of a frequency corresponding to a set cut off frequency.

[0029]

More preferably, the tuner portion includes a first AGC portion for adjusting amplitude of a signal corresponding to the reception channel to a prescribed level, and the tuner further includes a second AGC portion provided between the tuner portion and the down converter portion, for adjusting amplitude of the intermediate frequency signal of the first frequency band to a prescribed level.

[0030]

More preferably, the tuner portion and the down converter portion output signals of non-parallel type, the tuner further includes a signal converting circuit receiving an output of the down converter and converting to a parallel type signal.

[0031]

Further, more preferably, the mixer circuit amplifies the intermediate frequency signal of the first frequency band in the second mode.

[0032]

More preferably, the local oscillation circuit includes an oscillation element oscillating at the second frequency band, a first bipolar transistor receiving at an input electrode an output of the oscillation element, a first bias resistance coupled between the input electrode of the first transistor and a first voltage node, and a second bias resistance coupled between one of output electrodes of the first bipolar transistor and a first voltage node; and the mixer circuit includes a second bipolar transistor receiving at an input electrode an output of the oscillation element and the intermediate frequency signal of the first frequency band, a third bias resistance coupled between input electrodes of the first and second bipolar transistors, and a fourth bias resistance coupled between the input electrode of the second bipolar transistor and a second voltage node supplying a voltage higher than the first voltage node.

[0033]

Further, more preferably, the local oscillation circuit includes a switch element of which on/off is instructed externally, connected parallel to the oscillation element, the switch element turning on/off in the first and second modes, respectively.

[0034]

Further, more preferably, a down data signal of a band different from the multiwave down signal is input from the CATV station to the receiving portion through a cable, and the receiving portion includes a branching circuit branching and outputting the down data signal.

[0035]

Further, more preferably, the upstream circuit, the tuner, the high pass filter and the down converter are contained in a shield case partitioned individually.

[0036]

[Embodiments of the Invention]

In the following, embodiments of the present invention will be described in detail with reference to the figures.

[0037]

Fig. 1 is a block diagram representing a configuration of STB 100 in accordance with an embodiment of the present invention.

[0038]

Referring to Fig. 1, as compared with the conventional cable modem tuner 1 shown in Fig. 8, in the STB100 of the present invention, a branching circuit 25 connected to an OBB terminal 26, and a buffer amplifier 27 are connected to the output side of HPF 5, and in addition, the following points are different. More specifically, a QPSK modulated return pass signal is input to a data input terminal 3, and further input to PGA (Programmable Gain Control) 30 through LPF 34. Further, a QPSK signal is applied to and amplified by a power amplifier 33 included in PGA 30, and gain-controlled by a step attenuator 32 that is variable 1dB by 1dB.

[0039]

The control function is realized by I2C bus, 3 Wire bus or BCD cord, as a digital control signal input from gain control terminal 35, or an analog controlled AGC voltage, for example. The QPSK signal is further amplified by a power amplifier 31, and in total, that is, from the data input terminal 3 to input terminal 2, the gain is amplified to 26dB or higher. To this end, the gain at the PGA 30 must be 26dB to 30dB, in consideration of spurious emission by linearity. The output from PGA 30 is provided from input terminal 2 through LPF 40.

[0040]

Further, on the output side of mixers 18 and 20, a down converter 40 is provided.

Down converter 40 receives an IF input signal of High-IF output from intermediate frequency amplifying circuit 22, and converts an IF output signal suitable for QAM demodulation, which is selectively set to either the High-IF or Low-IF frequency band. The IF output signal is applied form an output terminal 47 of down converter circuit 40 to the QAM demodulating circuit.

[0041]

Here, blocks up to generation of the IF input signal, that is, components contained in the conventional cable modem tuner 1 are the same as those described above, and therefore, description thereof is not repeated.

[0042]

Down converter 40 includes a SAW filter 41 receiving an IF input signal, an intermediate frequency AGC circuit 42 (hereinafter also referred to as an IF-AGC circuit), a mixer circuit 43 for mixing an output signal of IF-AGC circuit 42 and an oscillation signal, a local oscillation circuit 44 for generating an oscillation signal in the frequency band corresponding to Low-IF, a filter circuit (LPF) 45 capable of switching cut-off frequency at the time when Low-IF output signal is output and High-IF signal is output, and parallel/non-parallel converting circuit 46 for converting a non-parallel signal output from mixer circuit 43 to a parallel signal.

[0043]

The IF input signal corresponding to the reception channel selected by the tuner is passed through the SAW filter 41, has its amplitude adjusted to a prescribed level by IF-AGC circuit 42, and thereafter fed to the mixer circuit 43.

[0044]

As will be described in detail later, down converter circuit 40 is capable of selectively outputting either the High-IF signal or the Low-IF signal, in accordance with an external switching instruction.

[0045]

When output of Low-IF signal is instructed externally (hereinafter also referred

to as Low-IF signal output mode), an oscillation signal corresponding to the Low-IF signal is output by the local oscillation circuit 44. Mixer circuit 43 mixes an output from IF-AGC circuit 42 with the oscillation signal, and provides the Low-IF signal. Filter circuit 45 sets the cut off frequency such that the signal of the Low-IF band is passed, in response to the external switch instruction. As a result, down converter circuit 40 down-converts the IF input signal to the Low-IF band, and outputs the result to parallel/non-parallel converting circuit 46.

[0046]

When the output of the High-IF signal is instructed externally (hereinafter also referred to as High-IF signal output mode), it is unnecessary for the down converting circuit 40 to perform frequency conversion, and what is necessary is simply to output the signal having the same frequency as the IF input signal. Therefore, in this case, oscillation of the local oscillation circuit 44 is stopped, and mixer circuit 43 operates as an intermediate frequency amplifying circuit. Here, filter circuit 45 sets the cut off frequency such that the signal of the High-IF band is passed, in response to the external instruction. As a result, down converter circuit 40 outputs the High-IF signal output to parallel/non-parallel converting circuit 46.

[0047]

Fig. 2 is a circuit diagram representing a specific configuration of the down converter circuit 40.

[0048]

Referring to Fig. 2, SAW filter 41 has a function of converting the IF input signal received from IF-AGC circuit 22 to a bandwidth to be transmitted, and of removing unnecessary signals. The SAW filter 41 is for extracting voltage oscillation caused by surface acoustic wave, by an electrode provided on a surface of a piezoelectric element, and characterized in that resonance characteristic is variable dependent on the position and structure of the electrode.

[0049]

IF-AGC circuit 42 includes a dual gate type field effect transistor T1, receiving an output signal from SAW filter 41 and an AGC voltage input to AGC terminal 48. Transistor T1 is provided for amplifying the output signal from SAW filter 41 in accordance with the AGC voltage. Between the AGC terminal 48 and one of the dual gates, resistance element R3 is connected, and corresponding to the AGC terminal 48 and one of the dual gates, ground capacitors C7 and C2 are provided, respectively.

[0050]

Between the SAW filter 41 and the other one of the dual gates, a resistance element R1 and a capacitor C1 for preventing DC component to transistor T1 are provided, and a gate bias resistance R2 is provided between the other one of the dual gates and the power supply terminal 49. An inductor L1 corresponds to a choke coil.

[0051]

The AGC voltage is set by the AGC control circuit (not shown) to secure the level 1Vp–p of the output IF signal applied from the output terminal 47 to the QAM demodulating circuit. The gain attenuation amount of IF-AGC by the IF-AGC circuit 42 having such a structure is about 50dB. Therefore, by the combination with the RF-AGC implemented by high frequency amplification circuits 11 and 12, it is possible to ensure a level of about 1Vp–p of the output IF signal.

[0052]

Mixer circuit 43 and local oscillation circuit 44 include bipolar transistors T2 and T3, respectively. Resistance elements R4, R5 and R8 provided as base bias for bipolar transistors T2 and T3 are connected in series. Therefore, cost advantageously, the number of components can be reduced, which is advantageous in view of cost.

[0053]

By setting the collector-emitter voltage V_{CE} of bipolar transistor T2 in mixer circuit 43 to 2.5V, and by setting V_{CE} of bipolar transistor T3 in local oscillation circuit 44 to about 1.5V, it is possible to reduce power consumption.

[0054]

Local oscillation circuit 44 further includes a quartz oscillator 50. Both the over tone type and fundamental wave type oscillators can be applied as the quartz oscillator 50. A capacitor C16 provided between the emitter of bipolar transistor T3 and the base of bipolar transistor T2 is a capacitance element for supplying the oscillation signal to the mixer. When bipolar transistors T2 and T3 are realized as twin type elements, it is possible to implement capacitor C16 by the parasitic resistance in the mold. This further reduces the number of components.

[0055]

Local oscillation circuit 44 further has a switch SW1 provided parallel to the quartz oscillator 50. By turning on the switch SW1 in response to an external switch instruction, the output node of quartz oscillator 50 can be forced to be connected to the ground node, attaining the same effect as stopping oscillation.

[0056]

Capacitors C4, C5 and C6 positioned in mixer circuit 43 and local oscillation circuit 44 are ground capacitances, while capacitors C8 and C10 are feed back capacitances. Capacitors C3, C9 and C11 are provided for preventing the DC component of the signal. The resistance elements R6, R7 and R10 are bias resistances provided corresponding to bipolar transistors T2 and T3, and resistance element R9 is a dumping resistance for adjusting oscillation frequency of quartz oscillator 50.

[0057]

Filter circuit 45 is formed, as an example, by a low pass filter in Fig. 2, and has an inductor L2 passing an output from mixer circuit 43, a capacitor C13 connected parallel to inductor L2, a switch SW2 connected parallel to the inductor L2 and capacitor C13, and capacitors C12 and C14 connected between the inductor L2 and the ground node.

[0058]

Cut off frequency of the filter circuit 46 can be switched by turning on/off the switch SW2 in accordance with an external switch instruction. More specifically, in the

High-IF signal output mode and the Low-IF signal output mode, SW2 is turned on and off, respectively.

[0059]

When switch SW2 is off, filter circuit 46 passes the Low-IF signal and attenuates the High-IF signal. Therefore, the values of capacitors C12, C13 and C14 and of inductor L2 are determined such that the cut off frequency is lower than the High-IF band and higher than the Low-IF band.

[0060]

When the switch SW is on, both ends of inductor L2 and capacitor C13 are short-circuited. Therefore, the cut off frequency goes high, and filter circuit 46 passes the High-IF signal as well. At this time, the value of capacitor C14 is set such that the cut off frequency at this time becomes higher than the High-IF band.

[0061]

In this manner, by providing a filter circuit 46 of which cut off frequency can be switched in accordance with an external instruction, it becomes possible to operate the filter circuit as an intermediate frequency tuning circuit.

[0062]

Further, as filter circuit 46 is connected as a load to mixer circuit 43, the effect of minimizing leakage of the local oscillation circuit 44 is also attained.

[0063]

The output of filter circuit 45 is transmitted to parallel/non-parallel converting circuit 46. Parallel/non-parallel converting circuit 46 converts the output of filter circuit 46 to 2-output signals different in phase by 90°, and provides as parallel outputs, to output terminal 47. As the output of STB 100 is turned to the parallel signals by parallel-non-parallel converting circuit 46, it becomes possible to directly connect the STB 100 to the QAM demodulating IC provided in the succeeding stage.

[0064]

If it has a configuration that has the same function and is capable of passing the

signals of the frequency ranges in the High-IF signal output mode and the Low-IF signal output mode, any structure may be used for filter circuit 46, other than the example shown in Fig. 2. The same applies to the configurations of IF-AGC circuit 42, mixer circuit 43 and local oscillation circuit 44.

[0065]

Switches SW1 and SW2 provided for local oscillation circuit 44 and filter circuit 46 are turned on in the High-IF signal output mode, and turned off in the Low-IF signal output mode. Switches SW1 and SW2 are commonly controlled in accordance with an external instruction. Electronic switches and mechanical switches may be used as switches SW1 and SW2.

[0066]

When switches SW1 and SW2 are turned on, oscillation of quartz oscillator 50 is stopped, and the cut off frequency of filter circuit 46 becomes higher. Therefore, mixer circuit 43 amplifies the IF input signal without changing the frequency thereof, and filter circuit 46 passes the High-IF signal.

[0067]

When switches SW1 and SW2 are off, the oscillation output of the Low-IF band of quartz oscillator 50 is amplified by local oscillation circuit 43 and transmitted to mixer circuit 44. Mixer circuit 44 mixes the oscillation signal received from local oscillation circuit 43 with the output signal of IF-AGC circuit 42, and provides a signal in the Low-IF signal band. The capacitance value of capacitor C13 in filter circuit 46 is set such that the signal in the Low-IF signal band is passed while the signal in the High-IF signal band is attenuated, when switch SW2 is off.

[0068]

Because of this structure, down converter circuit 40 including mixer circuit 43, local oscillation circuit 44 and filter circuit 46 outputs the signal in the High-IF band when switches SW1 and SW2 are on, and outputs a signal in the Low-IF band when switches SW1 and SW2 are off. More specifically, it becomes possible by a single

down converter circuit 40 to selectively output IF signals of different frequency bands, by turning on/off the switches. Thus, it can be commonly used for QAM demodulating ICs having inputs of different frequency bands.

[0069]

Here, when the circuitry including mixer circuit 43 and local oscillation circuit 44 except for the bias resistance R10 are arranged on one surface of a printed board, and filter circuit 46 and bias resistance R10 are arranged on the other surface of the printed board, a circuit configuration is attained in which output of the High-IF signal can be realized simply by the circuits mounted on the other surface of the printed board, and by adding the circuit configuration on one surface of the printed board, the circuit configuration is realized in which both Low-IF and High-IF signals can selectively be generated.

[0070]

As the switching function by switches SW1 and SW2 is provided, it is possible to mount the circuitry shown in Fig. 2 on one surface of the printed board.

[0071]

Fig. 3 is a block diagram showing the overall QAM demodulating system 300 in accordance with one embodiment of the present invention.

[0072]

Referring to Fig. 3, QAM demodulating system 300 includes STB100 shown in Fig. 2 and QAM demodulating circuit 200. Fig. 3 shows the main components of STB100, that is, HPF5, branching circuit 25, tuner portion 25, down converter circuit 40, LPF4, PGA30 and LPF34. Tuner portion 110 includes the components from buffer amplifier 27 to mixers 18 and 19 of Fig. 2.

[0073]

As already described, the IF signal output from STB100 can be set to either of the High/Low-IF frequencies, the signal is parallel type, and has the signal level of 1Vp–p. Namely, the signal is suitable as an input signal to QAM demodulating circuit 200.

Further, as the output of STB100 and the input of QAM demodulating circuit 200 are both made parallel type, the effect of suppressing external digital noise at the connecting portion therebetween can also be attained.

[0074]

The up signal of QPSK is provided from QMA demodulating circuit 200 as a modulation signal (upstream signal), and supplied through LPF34 to PGA30. PGA30 has its gain controlled by the control signal from QAM demodulating circuit 200. The signal from PGA30 is fed to input terminal 2 through LPF4. Another downstream signal is branched through HPF5 from a video signal, as OBB signal, by branching circuit 25. The OBB signal is supplied to QAM demodulating circuit 200.

[0075]

The video signal is selected by tuner unit 110, and input as an IF signal from down converter circuit 40 to QAM demodulating circuit 200. The QAM demodulated signal is applied as the data signal, to a transport decoder (not shown).

[0076]

Fig. 4 shows arrangements of various portions of STB 100 in accordance with an embodiment of the present invention. Referring to Fig. 4, an F type connector 301 is mounted on an outer side of a shield case 300, and the inside of shield case 300 is divided into sections 302 to 309 by partition plates 310. In section 302, HPF5, branching circuit 25 and buffer amplifier 27 shown in Fig. 1 are contained. In section 303, PGA 30 is contained, and in section 304, LPFs 4 and 34 are contained. In section 305, input switching circuits 6 and 7, and high frequency amplification input tuning circuits 8, 9 and 10 are contained, in section 306, high frequency amplification circuits 11 and 12 are contained, in section 307, local oscillators 19 and 21 are contained, and in section 308, mixers 18 and 20 are contained. Further, on a side surface of shield case 300, terminals 310 including a power supply terminal, a data terminal and the like are provided.

[0077]

By the shield case structured as described above, spurious emission appearing at the input end can be reduced, and flowing of high frequency up signal to the downstream side can be minimized.

[0078]

Fig. 5 is a plan of shield case 300, and Fig. 6 shows three sides of the shield case. As can be seen from Fig. 5, it is possible to form shield case 300 from one metal plate, by press machining, together with the side plates and the partition plates. After pressing, by bending the side plates and attaching the partition plates as shown in Fig. 6, the case can be manufactured at a relatively low cost.

[0079]

Fig. 7 represents main portions of the F type connector attaching portion.

In the periphery of the F type connector, the conventional shield case was not fit with the shield lid. In the embodiment shown in Fig. 7, a grounding piece 321 is formed on shield lid 320, and cut-out bending 311 is formed in shield case 300. By bringing the grounding piece 321 of shield lid 320 into pressure contact with the cut-out bending of shield case 300, the shield lid 320 can be fitted in the shield case 300. Thus, undesirable influence caused by external bus noise or the clock noise of the microprocessor can be reduced.

[0080]

The embodiments as have been described here are mere examples and should not be interpreted as restrictive. The scope of the present invention is determined by each of the claims with appropriate consideration of the written description of the embodiments and embraces modifications within the meaning of, and equivalent to, the languages in the claims.

[0081]

[Effects of the Invention]

As described above, according to the present invention, as a variable gain amplifier is provided as an upstream circuit, the gain specified by DOCSIS can be easily

set.

[0082]

Further, the down converter portion is provided that mixes an output of a local oscillator circuit, of which generation of an oscillation signal in a frequency band lower than the frequency band of the intermediate frequency signal output from the tuner portion can be executed/stopped in a switching manner, and an intermediate frequency signal of the frequency band output from the tuner portion, it becomes possible to selectively output intermediate frequency signals of different frequency bands by a circuit of one same configuration. As a result, it becomes possible to generally apply the CATV tuner to QAM demodulation circuits of different input frequency ranges. Further, as a filter circuit is connected to the output load of the mixer circuit, leakage of the local oscillation circuit can be suppressed.

[0083]

Further, in addition to the AGC portion of high frequency range included in the tuner portion, the AGC portion for intermediate frequency signal is provided, and therefore, variation of output signal related to the variation of the input reception signal level can be suppressed. As a result, a signal suitable as an input signal to the QAM demodulation circuit can be output.

[0084]

Further, as a signal converting circuit for converting a non-parallel signal to a parallel signal is provided, a signal suitable as an input signal to the QAM demodulation circuit can be output.

[0085]

Further, by forming the local oscillation circuit and the mixer circuit by bipolar transistors and connecting base bias resistances provided for respective bipolar transistors in series to each other, the cost can be reduced.

[0086]

Further, by switching the cut-off frequency of the filter circuit, it become

possible to additionally provide the function as an intermediate frequency tuning circuit.

[0087]

Further, as the AGC portion for the intermediate frequency signal and the signal converting circuit receiving a non-parallel output signal and converting it to a parallel signal are provided, it becomes possible to generate an output signal that can be directly input to the QAM demodulating circuit and to form an efficient QAM demodulation system.

[0088]

Further, as the tuner portion, the intermediate frequency AGC portion, the down converter portion and the signal converting circuit are contained in one same box, influence of external noise can be reduced.

[Brief Description of the Drawings]

Fig. 1 is a block diagram representing a configuration of STB 100 in accordance with an embodiment of the present invention.

Fig. 2 is a circuit diagram illustrating a specific configuration of down converter circuit 30.

Fig. 3 is a block diagram showing an overall system of QAM demodulation system 300 in accordance with an embodiment of the present invention.

Fig. 4 shows a shield case containing various circuits forming the CATV tuner in accordance with the present invention.

Fig. 5 is a development diagram of the shield case shown in Fig. 4.

Fig. 6 shows the assembled shield case.

Fig. 7 illustrates fitting between the shield case and the shield lid.

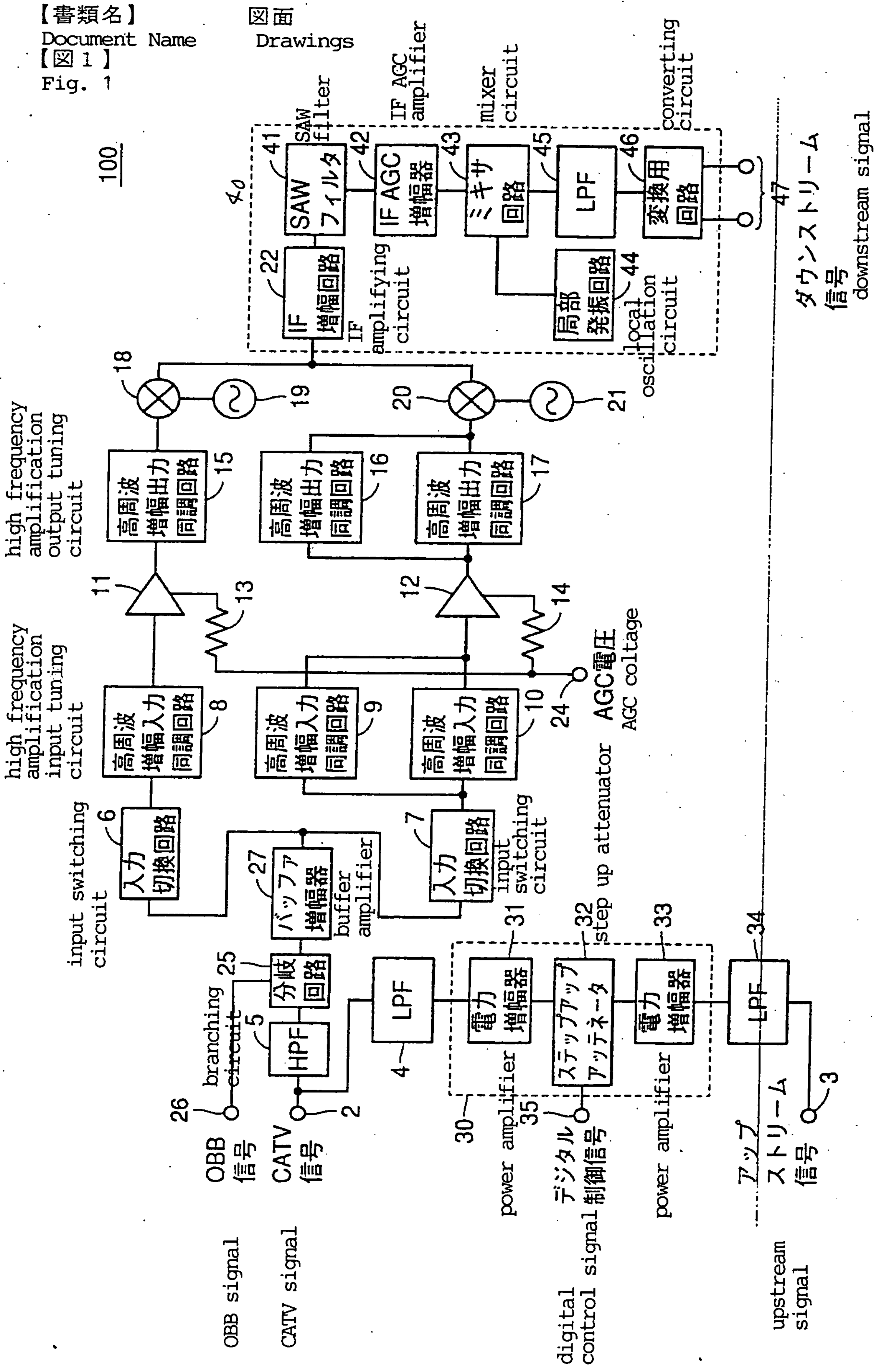
Fig. 8 is a schematic block diagram of a conventional cable modem tuner.

[Description of the Reference Characters]

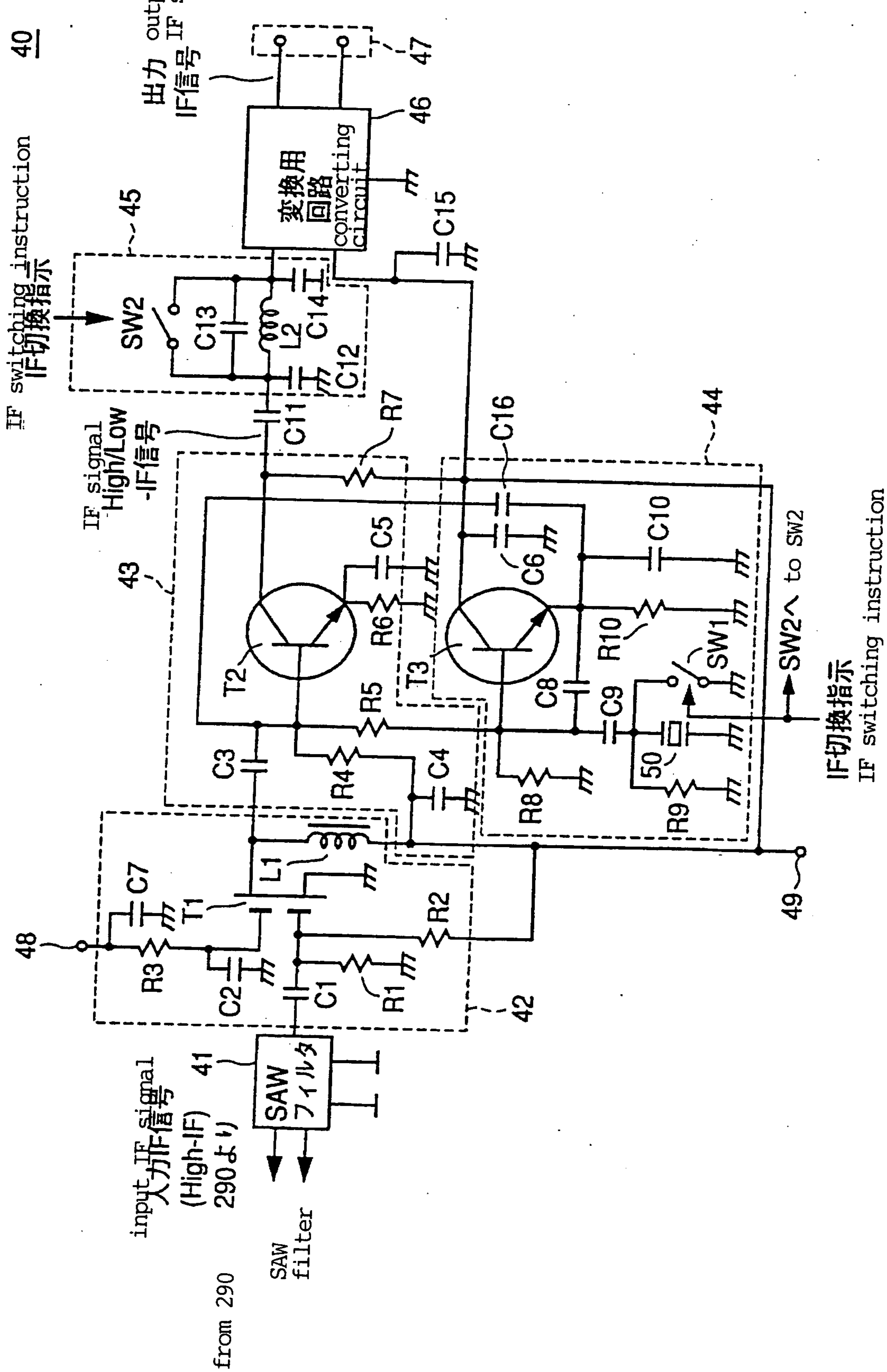
2, 3, 26, 47 terminal, 4, 34, 45 LPF, 5 HPF, 6, 7 input switching circuit, 8, 9, 10 high frequency amplification input tuning circuit, 11, 12 high frequency amplifier, 15, 16, 17 high frequency amplification output tuning circuit, 18, 19, 43 mixer circuit, 19, 21, 44

local oscillation circuit, 22 IF amplifying circuit, 30 PGA, 31, 33 power amplifier, 32 step up attenuator, 40 down converter, 41 SAW filter, 42 IF-AGC circuit, 46 converting amplifier, 300 shield case, 320 shield lid.

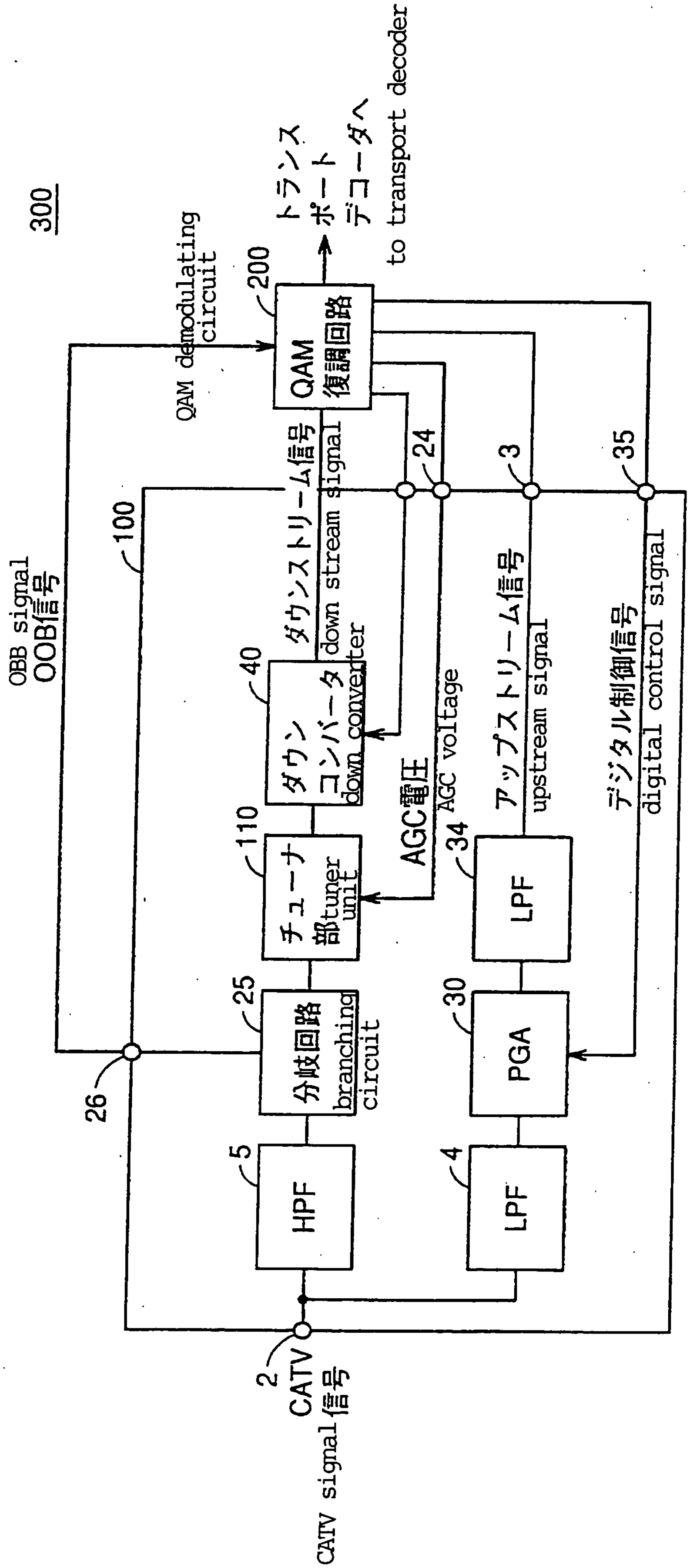
【書類名】　図面
Document Name　Drawings
【図１】
Fig. 1



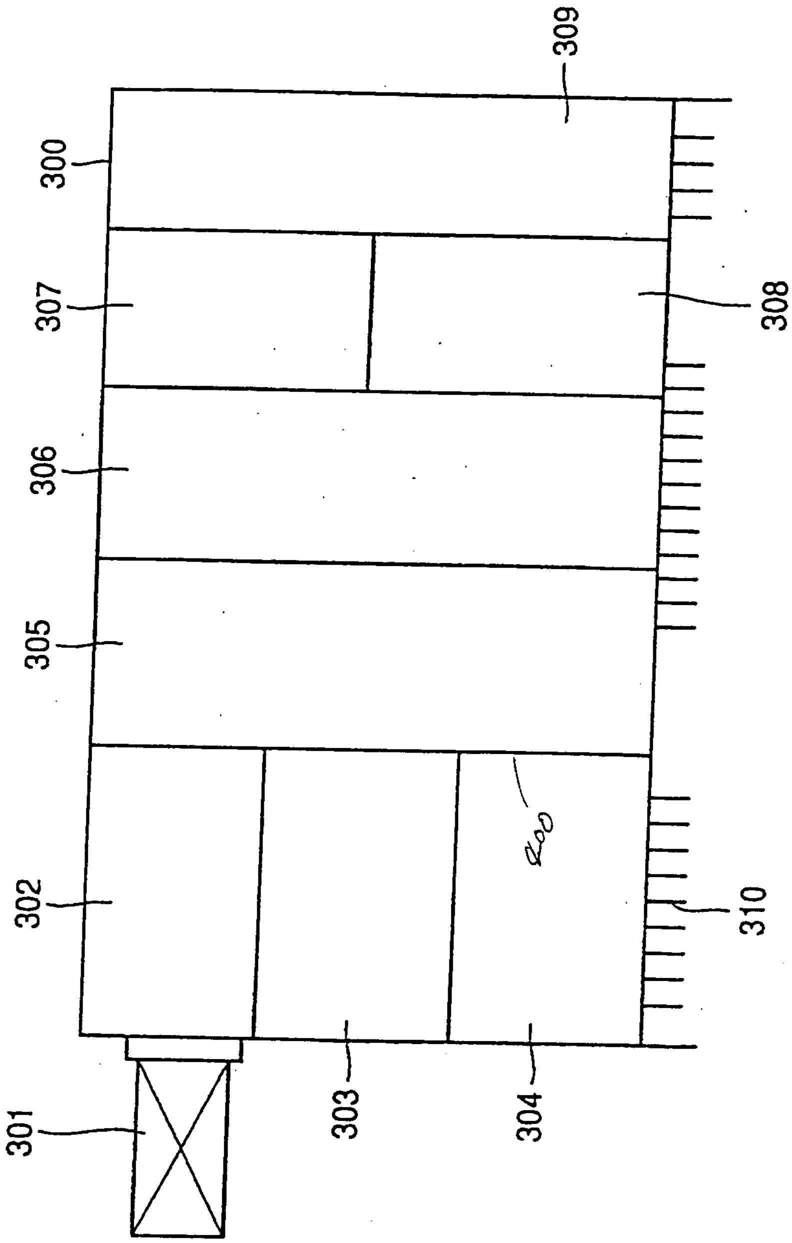
【図２】
Fig. 2


40
出力 IF信号
output IF signal
47
46
変換用回路
converting circuit
C15
45
IF switching instruction
IF切換指示
SW2
C13
L2
C14
C12
C11
High/Low -IF信号
IF signal
R7
C16
44
43
C5
C6
C10
T2
R6
T3
R10
SW1
SW2へ to SW2
IF切換指示
IF switching instruction
R5
C8
C9
50
C3
R4
C4
R8
R9
L1
C7
T1
R2
49
48
R3
C2
C1
R1
42
41
SAW フィルタ
SAW filter
入力IF信号 (High-IF) 290より
input IF signal
from 290

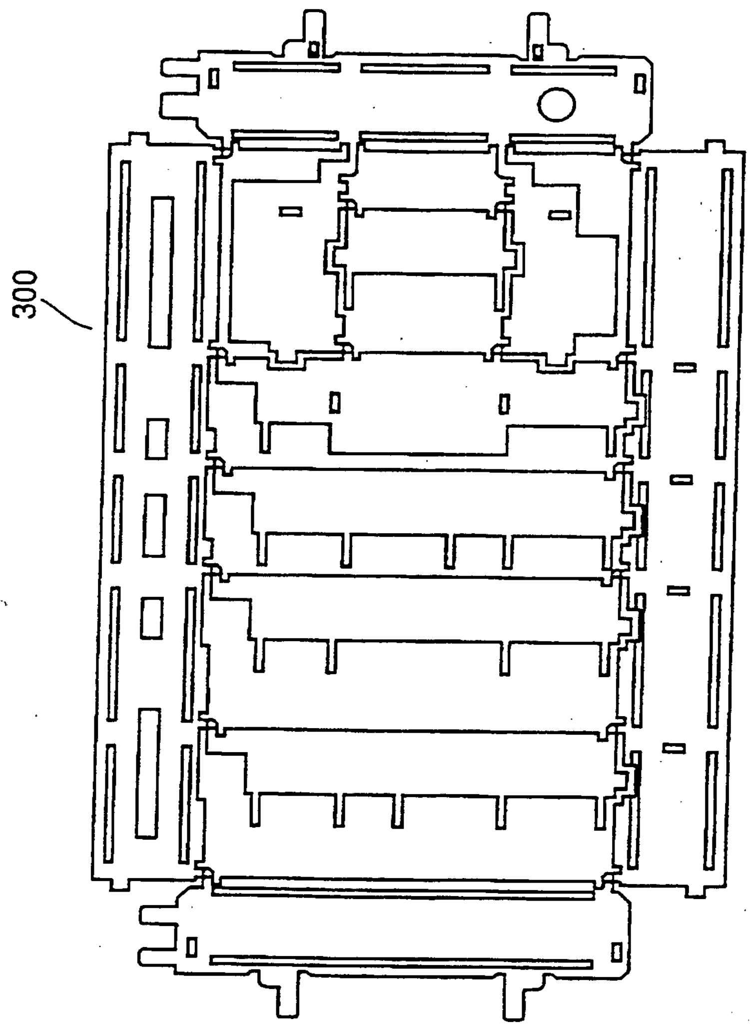
【図３】
Fig. 3


300
トランスポートデコーダへ
to transport decoder
200
QAM demodulating circuit
QAM 復調回路
OOB信号
OBB signal
100
ダウンストリーム信号
down stream signal
24
3
35
40
ダウンコンバータ
down converter
AGC電圧
AGC voltage
アップストリーム信号
upstream signal
デジタル制御信号
digital control signal
110
チューナ部
tuner unit
34
LPF
25
分岐回路
branching circuit
30
PGA
26
5
HPF
4
LPF
2
CATV信号
CATV signal

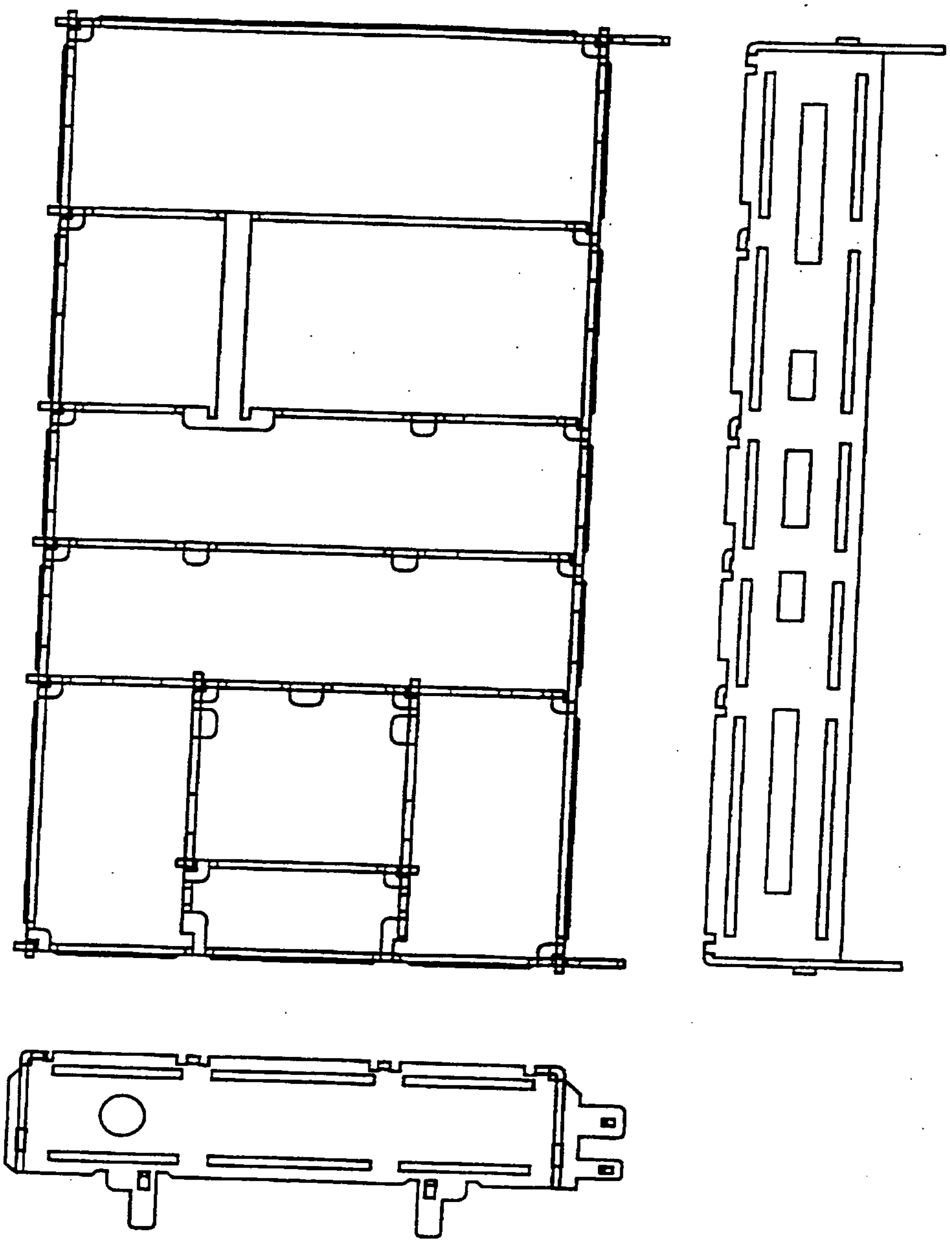
【図４】
Fig. 4



【図５】
Fig. 5



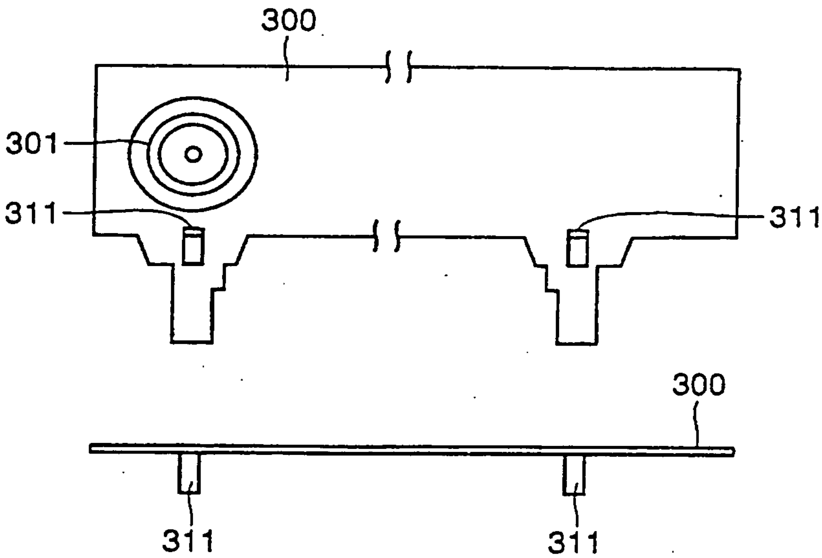
【図６】
Fig. 6



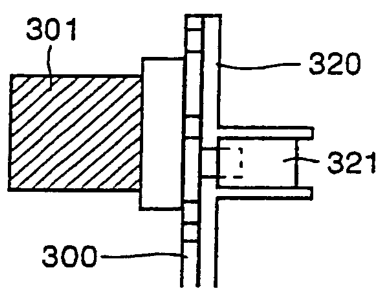
【図７】

Fig. 7

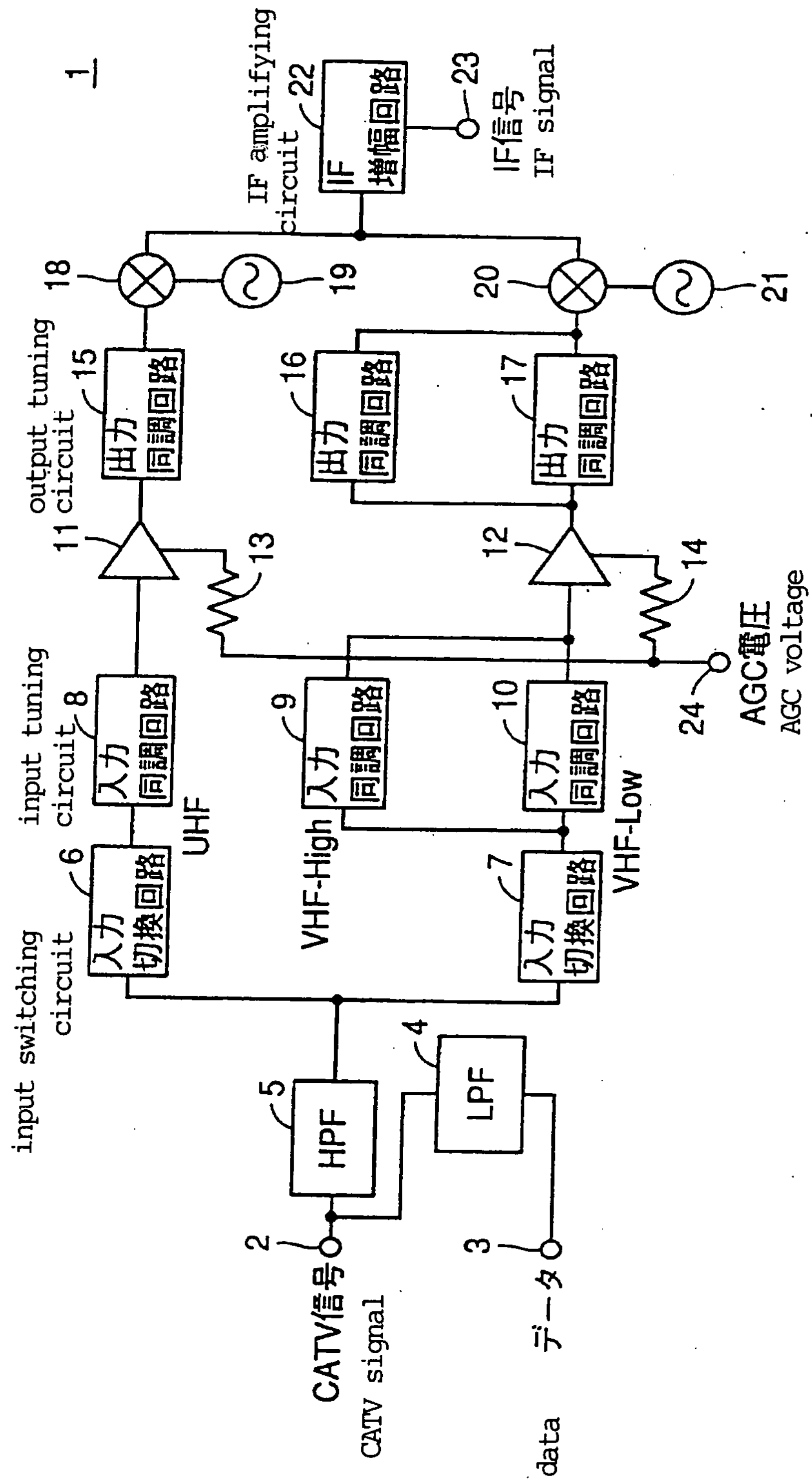
(a)



(b)



【図８】
Fig. 8


1
IF amplifying circuit
22
IF
増幅回路
23
IF信号
IF signal
18
19
20
21
output tuning circuit
15
出力
同調回路
16
出力
同調回路
17
出力
同調回路
11
12
13
14
input tuning circuit
8
入力
同調回路
9
入力
同調回路
10
入力
同調回路
24
AGC電圧
AGC voltage
input switching circuit
6
入力
切換回路
7
入力
切換回路
UHF
VHF-High
VHF-Low
5
HPF
4
LPF
2
CATV信号
CATV signal
3
データ
data

[Document Name] Abstract

[Abstract]

[Subject] An object is to provide a CATV tuner capable of outputting a signal suitable for QAM demodulation.

[Solving Means] In an upstream circuit for transmitting a data signal to a CATV station, a QPSK signal is input through an LPF (34) to a PGA (30), amplified by a power amplifier (33), has its gain controlled by a step up attenuator (32), and further power-amplified by a power amplifier (31), and then it is output from a terminal (2) through LPF (4) and transmitted to the CATV station. A downstream signal from the CATV station is passed through an HPF (5) and a branching circuit (25), and extracted through a tuner portion (110) by a down converter (40).

[Selected Drawing] Fig. 1